Reflective Energies

Focus III DG Interconnection Monitoring Program Quarterly Report

Task No. 2
CEC Contract No. 500-03-12

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1. Introduction & Executive Summary

Introduction

This quarterly report has been developed for Task 2.2 of the FOCUS-Interconnection project under Contract No. 500-03-12 between the California Energy Commission (Commission) and Reflective Energies. This FOCUS III quarterly DG Monitoring report is a continuation of the reports previously issued under FOCUS II (CEC Contract No. 500-00-013).

Background

This report presents the results of monitoring commercially installed DG for its impact on the grid and vice versa. This is the first time such a study has been undertaken anywhere. The study represents a small sample, a total of thirteen (13) generators at seven (7) locations are operational. Monitors for three additional sites with eleven (11) generators are in the planning stage or being installed this quarter. Monitoring started Aug 2002 and covers over 330,250 hours of data logged.

First Quarter Activity

During the quarter, each of the sites was monitored and analyzed for availability, power quality, SARFI and SATHD, and for DG On/Off analysis.

The installation of the Moscone site was delayed. SFPUC requested additional data and establishment of an agreement. The majority of these items are in have been delivered and the agreement is under development. The schedule has been modified and installation is due in the 3rd Quarter 2005.

One additional site is under evaluation at Chico. This site has four FuelCell Energy 250 kW Fuel Cells. The site survey is scheduled for July 2005.

2. Site Selection

Utilities/Municipalities Sites Selected for Monitoring

The Site Selection Guidelines were developed and submitted to the CEC for approval. Upon approval, additional sites will be sought conforming to the new guidelines. The guidelines include sites with large, multiple DGs, on Network Systems as priorities. Table 2-1 summarizes the sites selected and currently part of the Monitoring Project.

Table 2-2 provides a listing of the technologies included in the project while Table 2-3 shows the customer distribution.

Table 2-1
Utilities/Municipalities Desired Distribution

Site Distribution				
Utility/Municipalities	**Sites**	**DG**	**PCC Monitors**	**DG Monitors**
LADWP (FC & NGMT)	1	4	1	4
PG&E (NGIC – Synchronous)	1	1	1	1
SCE (FC, NGMT & PV))	3	4	3	3
SDG&E (NGIC – Synchronous)	1	2	1	1
SDG&E (NGIC – Inductive)	1	2	2	2
Subtotal (Operational)	**7**	**13**	**8**	**11**
PG&E (PV, NGIC – Inductive Pending)	1	4	1	4
PG&E (Fuel Cell Pending)	1	4	1	4
SFPUC (PV – Pending)	1	3	1	3
Subtotal (Pending)	**3**	**11**	**3**	**11**
Total	**10**	**24**	**11**	**22**

DG Technology Distribution

Table 2-2
DG Technology Distribution Plan and Progress

DG Technology Distribution			
DG Technology	**No. of Sites**	**Utility/ Municipality**	**Status**
Fuel Cell (FC)	3	LADWP (1) LA[1]	Survey 06/12/02 & 2/25/03 Install 03/26/03 & 4/23/03 Operational 6/23/03
		SCE (1) – Irvine	Survey 06/27/02 Install 09/8/02 Operational 9/8/02
		PG&E (1) - Chico	Survey 07/11/2005
Natural Gas Combustion Turbine (NGIC)	4	PG&E (1 Synchronous) - Sunnyvale	Survey 07/30/02 PCC Installed 11/14/02, NGIC 4/28/03 Operational 4/29/03
		PG&E (1 Inductive) – Santa Rosa [2]	Survey 11/16/04 Installed Pending Operational Pending
		SDG&E (1 - Synchronous) - San Diego	Survey 08/13/02, Install 01/20/03 Operational 02/11/03
		SDG&E (1 – Inductive_ – San Diego)	Survey 11/17/04, Install 02/18/05 Operational 03/19/05
Micro Turbine (MT, MMT or NGMT)	2	LADWP (1)	See FC
		SCE (1) - Redlands	Survey 07/02/02 & 08/04/04 Install 08/26/02 MGNT installed and startup 09/22/04 but gas pressure problems delay operation
Photovoltaic (PV)	3	SCE (1) – South Gate	Survey 07/08/02 Install 09/10/02 Operational 09/10/02
		PG&E (1) – Santa Rosa	See NGIC
		SFPUC (1) – San Francisco	Survey 06/14/04 & 11/16/04 Install Pending Operational Pending

[1] LADWP – One site with two technologies (FC & NGMT)
[2] Santa Rosa – One site with two technologies (NGIC & PV)

Site Locations & Details

Table 2-3
Site Locations & Details

Customer Type					
DG Technology (Utility/Municipality)	**Location**	**Size (kW)**	**Technology**	**IC Type**	**OP Mode**
Educational					
PG&E	Santa Rosa	80 280	PV (2 Sharp 40 kW PV Systems) NGIC (2 Hess 140kW Inductive Microgen)	P	PS/Cogen
Convenience Store					
SCE	South Gate	14	PV (1 14 kW BP HI Performance Thin Film PV system)	P	PS
Commercial Building					
LADWP	Los Angeles	120 300	NGMT (Capstone 2-C30 & 1-C60) FC (FuelCell Energy 1 DFC 300A)	P	PS
SCE	Irvine	200	FC (UTC 1-PC25)	P	PS
SDG&E	San Diego San Diego	400 400	NGIC (2 Hess 200 Synchronous Microgen) NGIC (2 Hess 200 Inductive Microgen)	P	PS/Cogen
SFPUC	San Francisco	676	PV (PowerLight PowerGuard Array Systems)	P	PS
Manufacturing					
PG&E	Sunnyvale	3000	NGIC (Waukesha - 16VAT27GL)	P	PS
PG&E	Chico	1000	FC (FuelCell Energy 4 DFC 300A	P	PS
Medical					
SCE	Redlands	120	NGMT (Capstone 2-C60)	P	PS/Cogen

Technology Key: DIC = Diesel Internal Combustion, MMT = Methane Micro turbine, NGMT = Natural Gas Microturbine, NGIC = Natural Gas Internal Combustion, NGCT = Natural Gas Combustion Turbine, PV = Photovoltaic, CT = Combustion Turbine, MIC = Methane Internal Combustion, Recip = Reciprocating
Interconnection (I/C) Type Key: P = Parallel, MP = Momentary Parallel, I = Isolated
Operating (OP) Mode Key: Cogen = Cogeneration, E/B/I = Emergency/Backup/Interruptible, PS = Peak Shaving

3. Measurements & Data Analysis

Data Analysis & Reporting Background

This is the first known project that is independently monitoring the power quality at the interface between the generator and the Distribution System. The project has developed a database of electric parameters at DG Interconnection and at the DG. The data is being analyzed using ION Enterprise™ web-ready software, which is a complete energy information management solution with control capabilities. Comprehensive power quality and reliability analysis helps pinpoint power quality and other problems that may arise from either the DG or the Distribution System.

The data is grouped by DG Technology and then compared with periods of operation and non-operation. The analysis also considers the following:

- Understanding how certain Distribution/DG operations can impact system performance and determine its effect on power quality at the interconnection
- Assess the DG Technology for typical electrical generation and the defined its power quality signature and impact on the grid.
- Perform analysis to identify measures to improve power quality for the DG Interconnection.
- Develop characterization of DG Interconnection Power Quality
- Provide results to the Rule 21 Working Groups for consideration of development of a recommended practice for providing standard DG Interconnection and possibility simplifying the screening and margins required in the Rule 21 process and application process

Since the monitoring will be conducted over a four-year period of time (two years FOCUS II plus two years FOCUS III), some of the data will be collected with the DG off line (example: down for maintenance) and other data will be collected during DG operation. When the DG is not operating, this data will establish a benchmark and baseline for the facility and distribution system, and this data can be compared to that collected when the DG is in operation. The combination will allow the analysis to look at the characteristics and interaction between the DG and the distribution system.

Current Status

Data is being collected from the following sites:

- Irvine (FC)
- Los Angeles (FC and NGMT)
- Redlands (NGMT)
- San Diego (Synchronous IC & Inductive IC)
- South Gate (PV)
- Sunnyvale (IC)

Of these sites, all generators except two microturbines at the Redlands Site are now in operation. Startup of the Redlands microturbines started 9/22/04 but ran into a problem with the gas pressure. Some modification was made and the restart also failed and alternate planning is under way at the facility.

The results for this report summarize the FOCUS III data collected for the 2nd Quarter 2005 and integrated into the FOCUS II data.

The database size is shown in Table 3-1 from seven operational sites consisting of nineteen (19) operational ION8500/7600/7650 Monitors. Two sites San Francisco PV and Santa Rosa IC Induction & PV sites are being constructed and not operational at this time. One site, Chico is in the planning stage.

Table 3-1 Database Size

DG Database Size

Date (from)	Date (to)	Size (kb)
Archive		
1-Jul-2002	30-Sep-2002	99,544
1-Aug-2002	31-Oct-2002	46,216
1-Oct-2002	31-Dec-2002	79,480
1-Jan-2003	1-Apr-2003	99,554
1-Apr-2003	30-Jun-2003	1,995,460
1-Jul-2003	1-Oct-2003	256,888
1-Oct-2003	1-Jan-2004	608,536
1-Jan-2004	31-Mar-2004	271,144
1-Apr-2004	30-Jun-2004	256,420
1-Jul-2004	1-Oct-2004	256,756
1-Oct-2004	31-Dec-2004	608,536
1-Jan-2005	1-Apr-2004	1,008,000
SQL Active Database		617,600
Total		6,204,134

Monitor Availability

Several communication problems continue, interrupting data transmission from the monitors to the Web Server. Although several firmware changes have been made to correct this condition at several sites, the problem has not been eliminated. During the quarter, Irvine & San Diego Synchronous Ethergate monitors firmware was upgraded from version 2.39 to 2.51.

Monitor availability is a measure of the time during the monitoring period that a power quality monitor was available for collecting data. Even though several communication problems occurred during this period, the overall availability average for the Focus II Monitoring Program monitors is now at **99.87%**.

Energy Summary

The Load Profiles (kWh) reports contain information about the power usage or generation for each site. They provide power information at the point of common coupling (PCC) and also provide the net power generated by the generators itself. While power generated or consumed is not by itself a measure of grid impact, it does provide an important reference to gauge when and why any grid impacts occur. Complete Load Profile reports for each site can be obtained by visiting dgmonitors.com.

Table 3-2 Load Profile Summary

Energy Summary (kWH)

Reflective Energies

January-01-2005

January-01-2006

Site	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	kWh
Irvine							
PCC	6421	3759	2564	10721	1566	1454	26486
FC	111833	118059	145670	87883	145850	141125	750419
Los Angeles							
PCC	11317	9467	3338	0	0	0	24122
FC	0	0	0	0	0	0	0
NGMT1	17300	14520	5135	0	0	0	36955
NGMT2	0	0	0	0	0	0	0
NGMT3	3738	3482	3782	3526	3554	3430	21512
Redlands							
PCC	133305	118111	138028	140371	162217	160568	852600
NGMT	0	0	0	0	75	0	75
San Diego							
PCC	165171	189122	169226	175679	207024	175223	1081446
NGIC	71443	28710	75861	67034	56203	81034	380285
South Gate							
PCC	42630	37262	40805	41324	41181	40024	243225
PV	755	878	1475	1913	2120	1896	9037
Sunnyvale							
PCC	4870654	1141884	4909925	4753405	4635506	4476178	24787552
NGIC	7142	7886	3422	25577	426220	411731	881977
Skypark							
9275 PCC			143474	154341	168948	163358	630121
9275 NGIC		3792	29502	31550	25327	32753	122924
9325 PCC			117242	63511	69400	69624	319778
9325 NGIC		9	2	24116	27135	29534	80796

Statistical Distributions of Voltage Sags and Interruptions

The results for sag and interruption magnitude rate for the events recorded by the Monitors between 8/26/02 to 7/1/2005 are summarized in Figure 3-1. The results represent all project monitors. Each column represents the rate of sags in which the minimum voltage fell into a particular range. For example, Figure 3-1 tells us that the average monitor experienced 11.10 incidents per 365 days (red bar) where the voltage was less than 90% (x-axis) of the site's base voltage.

If we consider the left-most columns of the histogram (0 to 10 % red bar), then we can say that the typical monitor experienced an average of 0.04 voltage interruption incidents per 365 days. The other columns represent voltage sags in which the minimum voltage fell to between 0.1 and 0.9 per unit.

Figure 3-2 provides the Sag & Interruption Rate Magnitude Histogram for the PCC monitors and DG monitors while Figure 3-3 provides the data for the individual DG technologies.

Figure 3-1 Sag & Interruption Rate Magnitude Histogram (All Monitors)

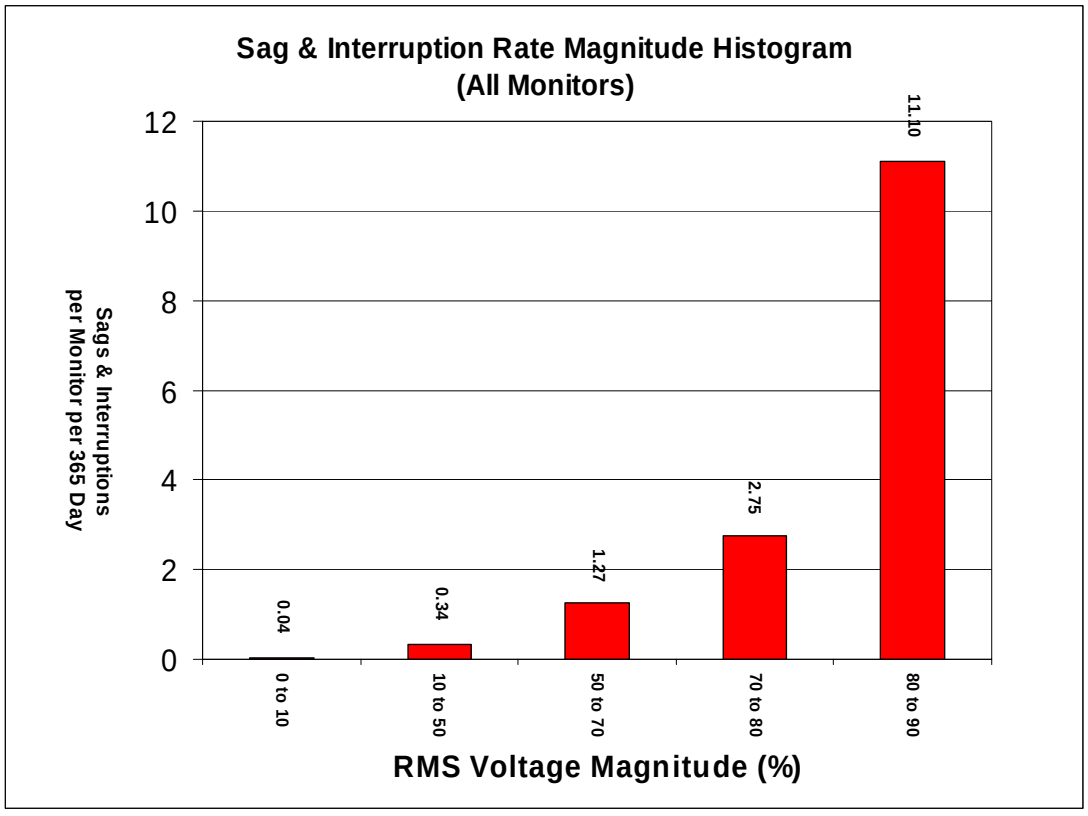


Figure 3-2: Sag & Interruption Rate Magnitude Histogram (DG & PCC Monitors)

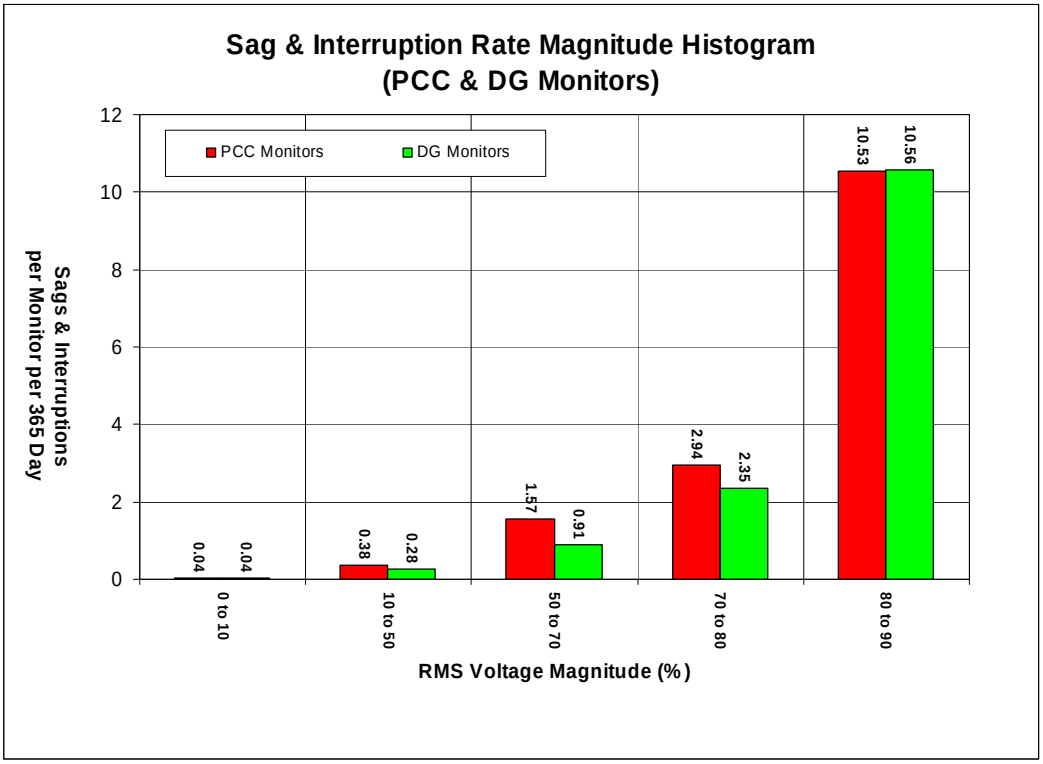
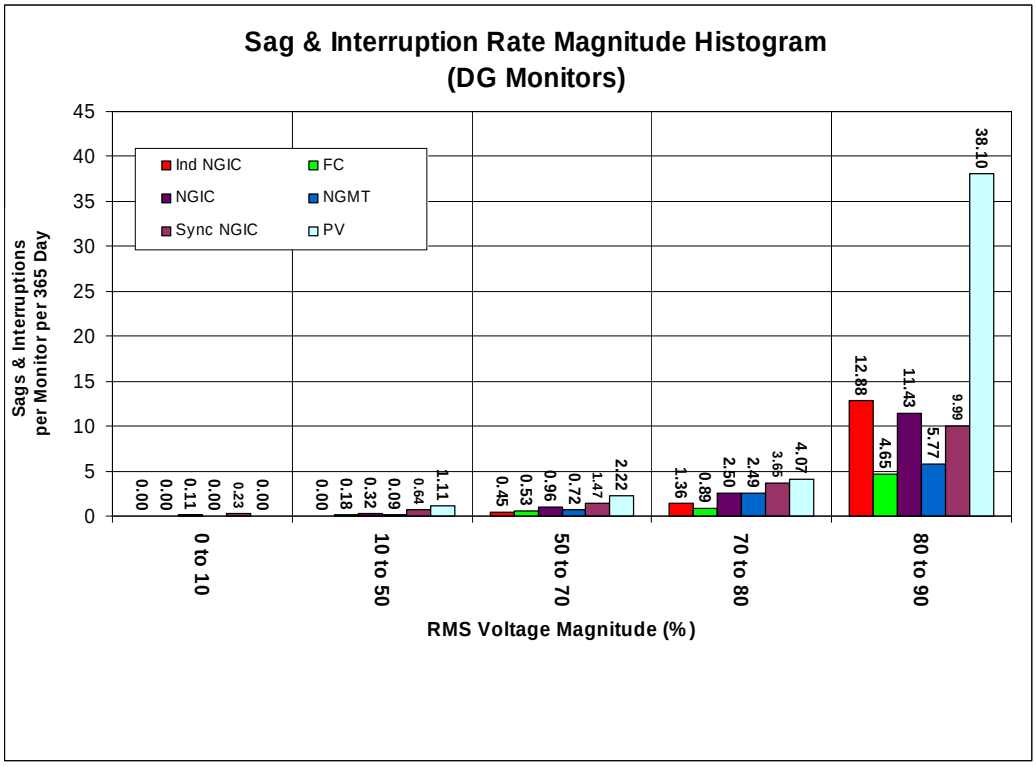


Figure 3-3: Sag & Interruption Rate Duration Histogram (DG Mentors)



SARFI: Sag and Interruption Rates

While Figures 3-1, 3-2 & 3-3 provide valuable information regarding average sag and interruption rates, an understanding of the range on values measured at different sites is also useful. To plot a range of values, we need to identify just one value of interest. If we consider just the incidents in which the minimum voltage fell below 0.90 per unit and temporally aggregate them with a 60-second period, then we can compute an index known as $SARFI_{90}$, which is a special case of $SARFI_x$.

A power system event occurrence is the real-world incident that triggers any number of measurements to be recorded by the ION 7600 or ION 8500. Examples include two conductors being blown together, a tree branch being brushed against one or more lines, lightning strikes, or the unfortunate act of an animal that creates an arc between part of the system and a grounded object. Other power system occurrences are planned, such as capacitor switching, and voltage reductions. We attempt to create a one-to-one relationship between temporally aggregated data and power system occurrences when computing system performance indices. For this section of the report, measurements were aggregated over one-minute intervals. The objective of temporal aggregation is to collect all measurements taken by the PCC monitor or the DG monitor that were due to the same power system occurrence, and identify them as one event. So we look at the PCC Monitor and the DG Monitor and see if an individual incident is the same. Then we compare the time stamp to find the source of the event and if they were within 60 seconds. Once that was determined, the SARFI analysis was completed.

Table 3-3 Temporal Aggregation (TA) of SARFI Indices

SARFI Comparison

From: August 1, 2002

Reflective Energies To: July 1, 2005

	Monitor Location & Technology (from 8/26/02 to 7/1/05)	$SARFI_{10}$	$SARFI_{50}$	$SARFI_{70}$	$SARFI_{80}$	$SARFI_{90}$
Temporal Aggregation SARFI Analysis	**Project Average**	0.04	0.34	1.27	2.75	11.10
	PCC Average	0.04	0.38	1.57	2.94	10.53
	DG Average	0.04	0.28	0.91	2.35	10.56
	Fuel Cell Average	0.00	0.18	0.53	0.89	4.65
	NGMT Average	0.00	0.09	0.72	2.49	5.77
	NGIC Average	0.11	0.32	0.96	2.50	11.43
	Synchronous	0.23	0.64	1.47	3.65	9.99
	Inductive	0.00	0.00	0.45	1.36	12.88
	PV Average	0.00	1.11	2.22	4.07	38.10

Monitoring SARFI Rates

In Table 3-2, we present a summary of the indices for $SARFI_{90}$, $SARFI_{70}$, $SARFI_{50}$, and $SARFI_{10}$ for each of the FOCUS-II Monitors. The results are sorted in descending order based on the $SARFI_{90}$ value. The PV monitor at South Gate exhibit the highest rate of $SARFI_{90}$ rms voltage variations, recording 38.10 short-duration rms voltage variations with a voltage drop below 0.90 per unit per 365 days. The average value for the $SARFI_{90}$, $SARFI_{80}$, $SARFI_{70}$, $SARFI_{50}$, $SARFI_{10}$ (sag) and $SARFI_{100}$ (swell) rates is given at the bottom of Table 3-3. A comparison to the Edison DPQ Project Service Entrance averages for the same indices is provided for reference in Table 3-3.

Table 3-4 Average Events per Year by SARFI Type

Monitor Location (from 8/26/02 to 7/1/2005)	$SARFI_{10}$	$SARFI_{50}$	$SARFI_{70}$	$SARFI_{80}$	$SARFI_{90}$	$SARFI_{100}$
South Gate PV	0.00	1.11	2.22	4.07	38.10	0.37
9325 Skypark NGIC	0.00	0.00	0.45	1.36	23.95	0.00
Redlands PCC	0.35	2.11	6.32	13.34	20.71	0.00
9325 Skypark PCC	0.00	0.00	0.00	0.00	20.33	0.00
South Gate PCC	0.00	0.00	1.48	2.59	17.01	0.00
Sunnyvale PCC	0.00	0.00	1.81	3.16	16.72	0.00
Redlands NGMT	0.00	0.35	1.40	7.02	14.74	0.00
Sunnyvale NGIC	0.45	0.45	0.90	3.61	12.20	0.00
San Diego PCC	0.00	0.82	2.46	4.50	10.23	38.06
Irvine FC	0.00	0.36	1.07	1.78	7.82	0.00
Irvine PCC	0.00	0.00	1.07	1.42	7.82	0.00
San Diego NGIC	0.00	0.82	2.05	3.68	7.78	34.79
Los Angeles NGMT1	0.00	0.00	0.98	1.47	2.94	0.98
Los Angeles NGMT3	0.00	0.00	0.00	0.49	2.94	3.43
Los Angeles NGMT2	0.00	0.00	0.49	0.98	2.45	0.98
Los Angeles PCC	0.00	0.49	0.98	1.47	1.96	0.49
9275 Skypark NGIC	0.00	0.00	0.45	1.36	1.81	0.00
Los Angeles FC	0.00	0.00	0.00	0.00	1.47	1.47
9275 Skypark PCC	0.00	0.00	0.00	0.00	0.00	0.00
Project SARFI Totals	0.04	0.34	1.27	2.75	11.10	4.24
PCC SARFI Totals	0.04	0.36	1.31	2.68	11.21	4.03
DG SARFI Totals	0.04	0.29	1.12	2.56	10.01	4.03
SCE Study Average	1.48	4.93	12.01	21.75	47.42	N/A

Event Duration Analysis

Figure 3-4 illustrates the results for sag and interruption duration rate analysis, using one-minute temporal aggregation, for the events recorded for all monitors. Figure 3-5 provides the same data for PCC monitors while Figure 3-6 contains the data for the DG monitors. The results for sag and interruption duration analysis for the events recorded by the FOCUS-II Monitors between 8/26/02 to 7/1/2005 are summarized in these Figures. Each column represents the number of sags in which the minimum voltage fell below 90 pu. It then correlates these events with the duration of the event to obtain an appreciation of the severity of the event. For example, Figure 3-4 (all monitors) tells us that 52 incidents (No. of Sags & Interruptions – Primary Y-Axis) occurred with duration of 1 cycle or less and this represents 10% of the sag events (Cumulative Frequency – Secondary Y-Axis). The 52 incidents is made up of 20 PCC (Figure 3-5) and 32 DG (Figure 3-6). The red bar is the number of events in each duration category and the blue line is the accumulative frequency (percent) of the events.

Figure 3-4: Sag & Interruption Rate Magnitude Histogram (All Monitors)

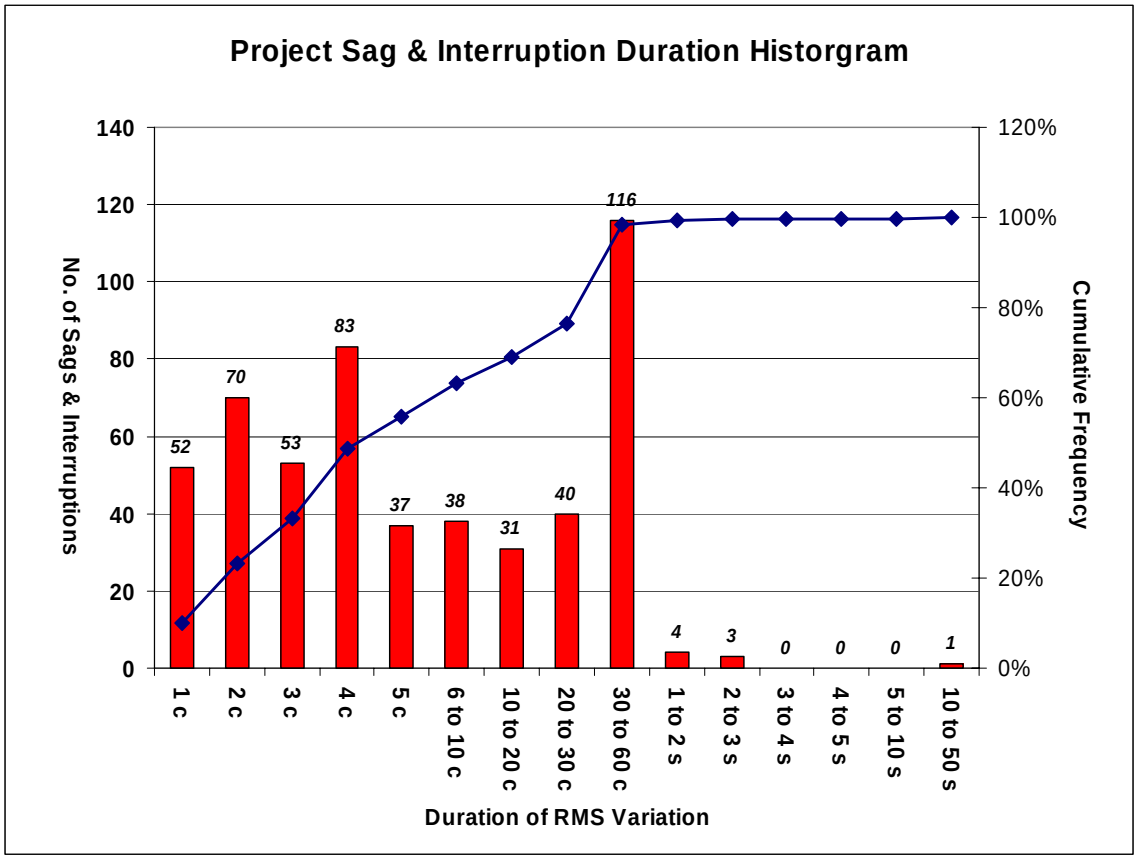


Figure 3-5: Sag & Interruption Rate Magnitude Histogram (PCC)

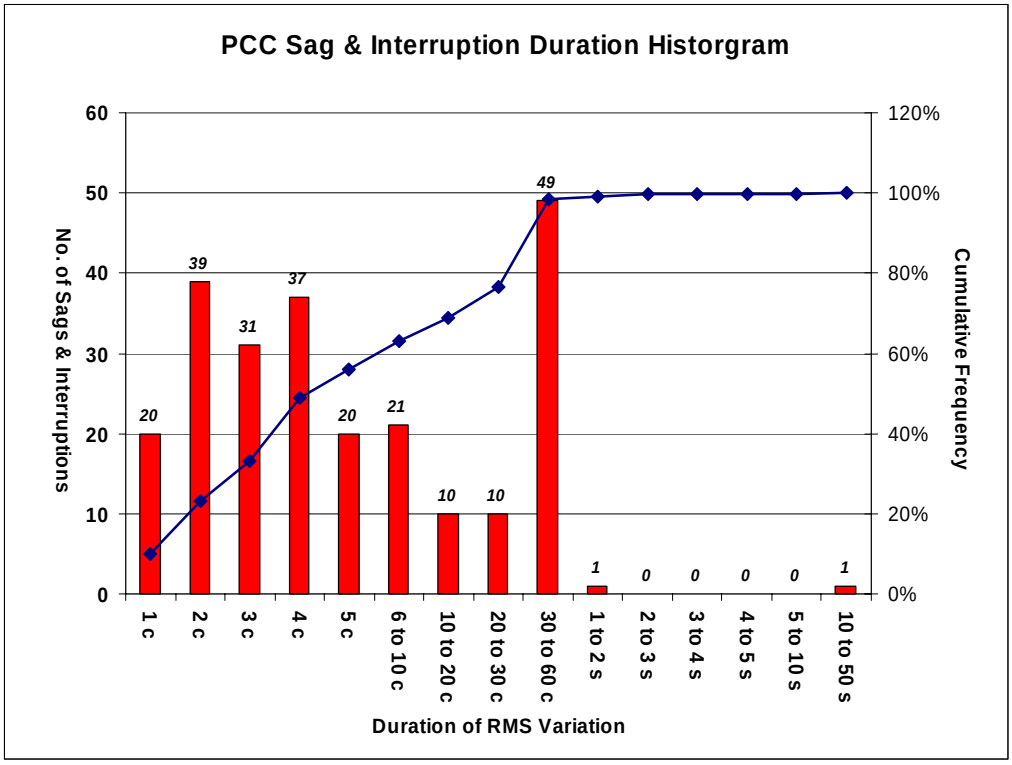
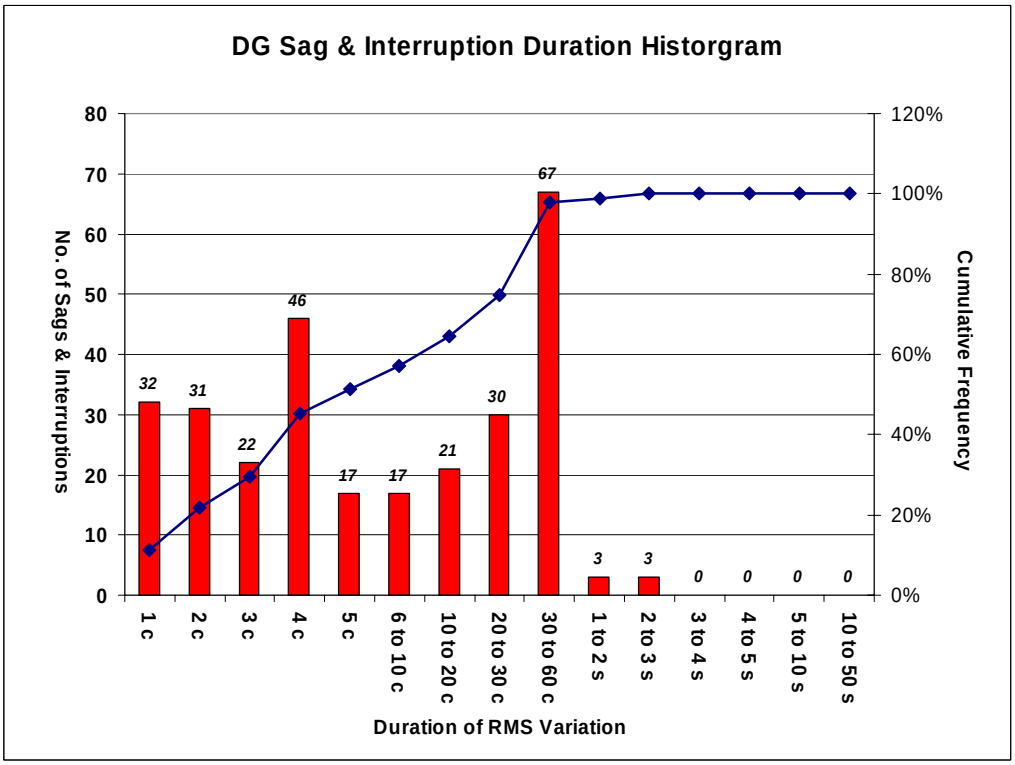


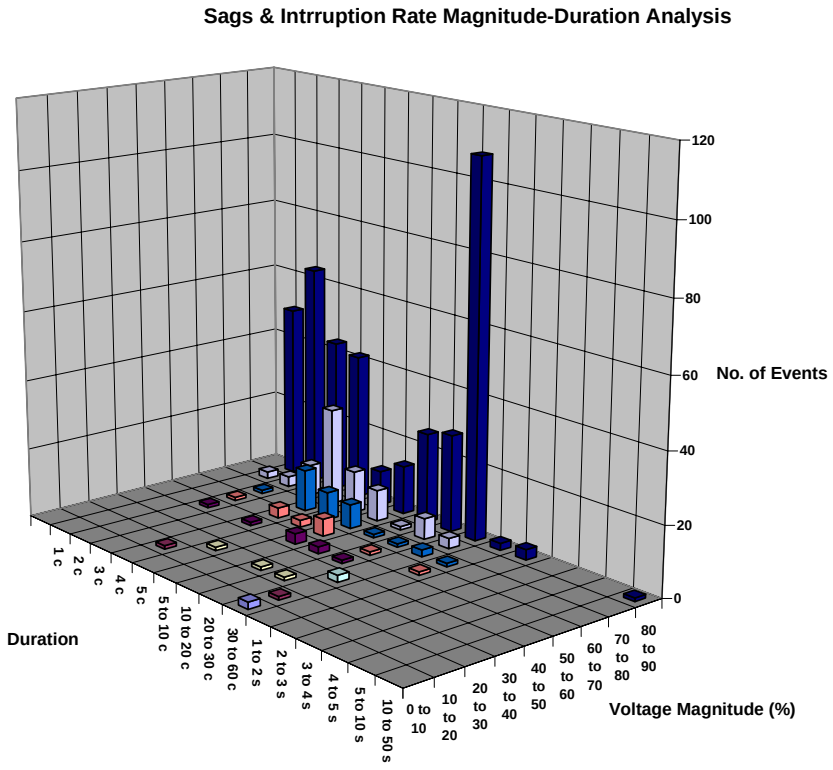
Figure 3-6: Sag & Interruption Rate Magnitude Histogram (DG)



Magnitude-Duration Analysis

If we combine Figures 3-4, 3-5 & 3-6 into one chart analyzing the events as a function of minimum voltage magnitude and event duration, we obtain the three-dimensional column chart presented in Figure 3-7. The data provided is the Magnitude Duration Event Log of individual rms voltage variations recorded by the monitoring system during the period from 8/26/02 to 7/1/2005. The measurements were subjected to Temporal Aggregation using a 60-second time interval.

Figure 3-7 Sag & Interruption Rate Magnitude-Duration Histogram



Flicker

A flicker disturbance is a repetitive low-frequency modulation of system voltage. A large fluctuating load somewhere within the power system usually causes these disturbances. Lighting systems will typically "flicker" when such disturbances occur.

All monitors were in compliance with the Flicker requirements for the 2nd Quarter 2005. Detail data can be found on the Web Site.

DG ON/OFF Analysis

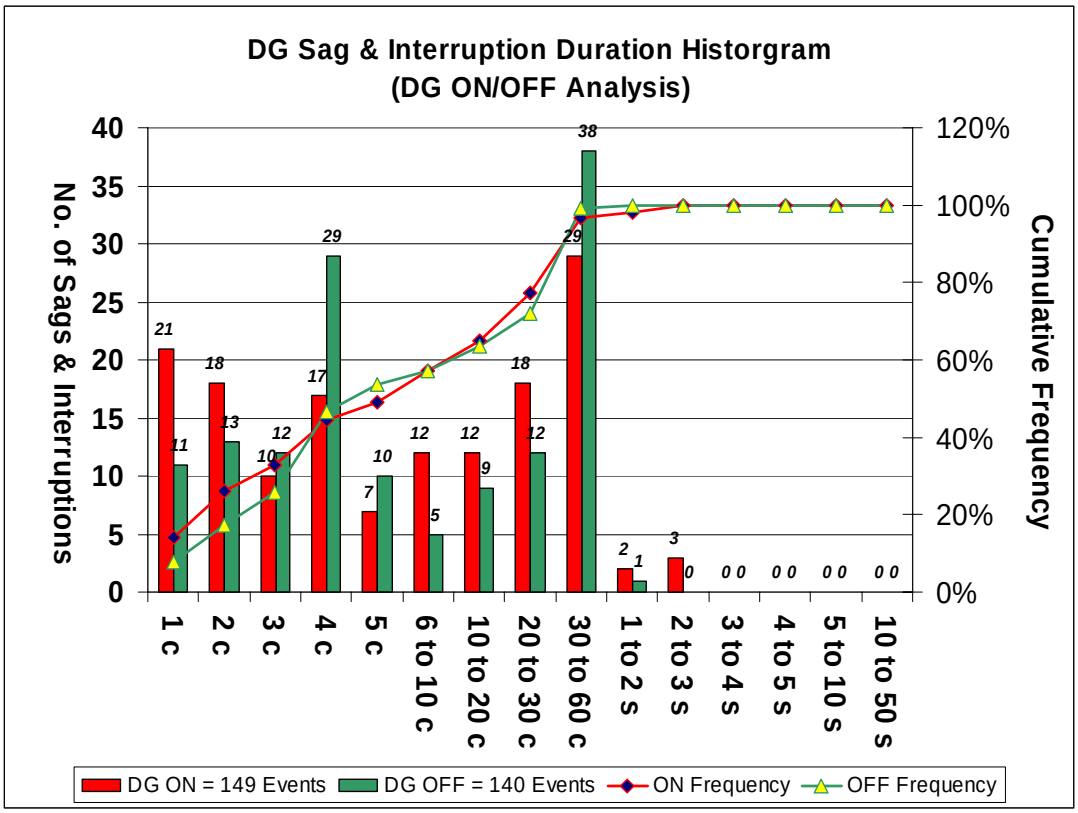
The study did look at the operational status of the DG and we find the following operational percentage for the period July 02 through March 05.

Table 3-5 DG ON/OFF Analysis

Operational Percentage	2002	2003	2004	2005	Average
Irvine – FC	92.14	91.56	75.46	92.04	85.97
Los Angeles – FC		74.75	59.24	0.00	50.91
Los Angeles – NGMT1		86.00	95.62	36.71	70.30
Los Angeles – NGMT2		25.95	21.86	0.00	18.26
Los Angeles – NGMT3		85.48	100.00	100.00	95.34
Redlands – NGMT	0.00	0.00	0.00	2.48	0.43
San Diego – NGIC		69.69	40.65	39.79	51.70
South Gate – PV	38.39	45.20	44.52	46.13	44.80
Sunnyvale – NGIC		37.68	9.04	7.49	19.33
9275 Skypark - NGIC				30.64	30.64
9325 Skypark - NGIC				28.35	28.35

Looking at the sag disturbances for the DG during the ON and OFF periods shows that of the 293 DG events, 149 were attributed to when the DG is on-line while 140 when it was off-line. 17.7 percent of the sag disturbances occurred during startup (50) or shutdown (2) of the DG.

Figure 3-8 DG ON/OFF Analysis



Harmonic Distortion

The Power Harmonics module in the meter provides an in-depth analysis of power system parameters for a selected harmonic. The module measures voltage and current levels for the selected harmonic, and derives kW, kVAR, kVA, Voltage Angle, Current Angle and Phase Angle values for each phase. The Harmonics Analyzer module provides detailed harmonics calculations for a voltage or current input on the device. This information is valuable for power quality analysis, selecting properly rated transformers, and fault detection. It can calculate the following harmonic distortion values as a percentage of the fundamental:

- % harmonic distortion
- total harmonic distortion
- total odd harmonic distortion
- total even harmonic distortion
- K-Factor (for current inputs)

The harmonic distortion measured at the Irvine Fuel Cell Site monitors had the highest values of voltage harmonic distortion but was still less than 5%.

IEEE Std. 519-1992 suggests the power provider strive to limit voltage harmonic distortion to a value of 5%. All of the Focus II Monitoring monitors were within this 5% SATHD limit for the 2nd Quarter 2005. The sites are listed in Table 3-4 and the Irvine site had the highest SATHD value.

Table 3-6 Harmonic Distortion Analysis

Monitor Location (from 8/26/02 to 7/1/2005)	SATHD	STHD95	STHD99
Irvine PCC (Commercial Building)	3.42	4.03	4.27
Irvine FC (UTC PC25)	3.42	4.03	4.27
Los Angeles PCC (Commercial Building)	1.11	1.80	2.08
Los Angeles FC (Fuel Cell Energy DFC300)	1.11	1.80	2.08
Los Angeles NGMT1 (Capstone C30)	1.11	1.80	2.08
Los Angeles NGMT2 (Capstone C30)	1.11	1.80	2.08
Los Angeles NGMT3 (Capstone C60)	1.11	1.80	2.08
Redlands PCC (Medical Facility)	0.44	0.72	0.83
Redlands NGMT (Capstone C60)	0.44	0.72	0.83
San Diego PCC (Commercial Building)	1.09	1.65	1.88
San Diego NGIC (Hess 200 Microgen - Sync)	1.09	1.65	1.88
South Gate PCC (Convenience Store)	1.19	1.69	1.93
South Gate PV (BP 14 kW)	1.19	1.69	1.92
Sunnyvale PCC (Manufacturing Facility)	0.11	0.40	0.49
Sunnyvale NGIC (Waukesha 3000 kW)	1.35	1.51	1.56
9275 Skypark PCC (Commerical Building)	1.24	1.53	1.67
9275 Skypark NGIC (Hess 200 Microgen - Ind)	1.24	1.53	1.67
9325 Skypark PCC (Commerical Building)	1.43	1.78	1.93
9325 Skypark NGIC (Hess 200 Microgen - Ind)	1.45	1.80	1.96
THD Average	**1.32**	**1.82**	**2.03**

4. Acronyms

ac ..... alternating current
ASD ..... adjustable speed drive
CBEMA ..... Computer Business Equipment Manufacturers Association
CHP ..... combine heat & power
CT ..... current transformer
dc ..... direct current
DG ..... Distributed Generation
DIC ..... diesel internal combustion
DPQ ..... distribution power quality
EI ..... Edison International
EPRI ..... Electric Power Research Institute
FC ..... fuel cell
FFT ..... Fast Fourier Transform
Hz ..... Hertz
IEEE ..... Institute of Electrical and Electronics Engineers
ITIC ..... Information Technology Industry Council
kA ..... kilo-amperes (1000 amperes)
kV ..... kilo-volts (1000 volts)
kVA ..... kilo-volt-ampere (1000 amps)
kVAR ..... kilo-var (1000 var)
kW ..... kilo-watts (1000 watts)
kWh ..... kilo-watt hour (1000 watt hours)
LADWP ..... Los Angeles Department of Water & Power
MCT ..... methane combustion turbine
MIC ..... methane internal combustion
mK ..... mega-watts (1000000 watts)
MMT ..... methane microturbine
NGCT ..... natural gas combustion turbine
NGFC ..... natural gas fuel cell
NGIC ..... natural gas internal combustion
NGMT ..... natural gas microturbine
PC ..... personal computer
PCC ..... point of common coupling
PG&E ..... Pacific Gas & Electric
PLC ..... programmable logic controller
PQ ..... power quality
PT ..... potential transformer
pu ..... per unit
PV ..... photovoltaic
RMS ..... root mean square
SARFI ..... System Average RMS Variation Frequency Index
SCE ..... Southern California Edison
SDG&E ..... San Diego Gas & Electric
SFPUC ..... San Francisco Public Utility Commission
SEMI ..... Semiconductor Industry Council
SMUD ..... Sacramento Municipal Utility District
TDD ..... total demand distortion
THD ..... total harmonic distortion
UPS ..... uninterruptible power supply
VAR ..... unit of reactive power (reactive volt-ampere